

Technology

Setting Tradition on Its Ear: *Voices* Audio-Based Environments and Gaming Enhance Navigation Skills for the Blind

For years orientation and mobility (O&M) researchers have studied the ways in which individuals with blindness and low vision get around, or navigate. Traditionally, says Dr. Lotfi Merabet, the assumption has been that blind people, especially early-blind children, have cognitive difficulties in representing spatial environments. These cognitive difficulties were presumed to result in impaired navigation skills. However, he notes, new research – involving the use of consumer-oriented audio technology, including gaming – is setting tradition on its ear.

In fact, reports Dr. Merabet, a Harvard Medical School-trained clinical researcher at Massachusetts Eye and Ear Infirmary in Boston where he is Director of the Laboratory for Visual Neuroplasticity, recent studies, including his, report that no differences exist in terms of how well blind individuals represent and interact with spatial environments. In some cases these individuals actually exhibit superior performance in certain navigational tasks when compared to sighted control subjects. This has led Dr. Merabet and his colleagues to question whether differences in spatial mental constructs and navi-

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gation skill are due solely to visual deprivation or whether they reflect an “impoverished or incomplete acquisition of necessary spatial information through other sensory channels.” To answer that question, they have turned to audio gaming and other consumer-based technology, to explore their ability to enhance spatial mapping and navigation skills.

Lotfi Merabet, O.D., Ph.D. Speaks

In May 2009 Dr. Merabet and his research colleague, Dr. Jaime Sanchez of the University of Chile’s Computer Science Department, published a research paper entitled Audio-Based Navigation Using Virtual Environments: Combining Technology and Neuroscience (<http://www.cnib.ca/en/research/news/gaming/Documents/aerj-02-03-128-137.pdf>).

The paper described the virtual audio environment developed by the two researchers that resembles, in principle, how flight simulators used for pilot training. The researchers shared the results of several studies involving individuals with severe visual impairments. The studies included the use of a specially designed software to create a virtual world of sound – a “soundscape” in Dr. Merabet’s parlance – in which blind participants were taught to develop mental spatial maps to aid in orientation and navigation. Since then, Dr. Merabet and Dr. Sanchez have teamed in similar studies conducted with participants from the Carroll Center for the Blind (<http://carroll.org/>) in Newton, MA. They have also conducted parallel studies using audio game technology with school children in Chile including the Santa Lucia and Heller Keller Schools for the Blind. Dr. Merabet’s interest in his research specialty, he says, was piqued when he was a fulltime neuroscientist intrigued by the links between the human brain and the visual system. At the same time, he also harbored aspirations of becoming a clinician, “so becoming an optometrist and eye doctor provided me with more patient contact and interac-

tion. Interestingly, though, as time passed I became more intrigued by how sightless individuals navigate their environment than with the capabilities of sighted persons.” He wanted know, for instance, “if the blind hear better, if their sense of touch is keener and if the other senses compensate for the absence of sight. We heard about these issues anecdotally but [as a clinician-scientist] I’d be in a position to investigate them in a more rigorous manner.” Fortunately, he adds, the intellectual environment in Boston facilitated in-depth investigation “because here we have the combination of great schools for the blind, centers and facilities for the blind, top-notch neurologists, eye doctors and neuroscientists. All the pieces are there.”

“We have a very different philosophy in approaching these issues compared to what’s been done in the past,” says Dr. Merabet. “I’ve often had the opportunity to visit hospitals and rehabilitation centers where ideas and strategies to assist the blind in various tasks had originated. But these were designed by sighted people, brought to market by sighted people. Instead, we try to work closely with visually impaired individuals on the front end because ultimately they can tell us what they need, what they want and what is effective for them. I think our approach has proven to be much more fruitful.”

A native of the USA and raised in Canada, Dr. Merabet completed his doctorate in neuroscience at the University of Montréal and his clinical doctorate in optometry at New England College of Optometry. He continued his post-doctoral training at Harvard Medical School, Boston University and the MGH Martinos Center for Biomedical Imaging and completed his Master’s degree in public health at Harvard. His work is currently supported by the National Institutes of Health (NIH).

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Enhancing the Navigational Skills of the Blind: Creating a “Soundscape” Virtual Audio Environment

An Interview with Lotfi Merabet, OD, PhD ,
Neuroscientist, Optometrist and Clinical
Researcher; Director, Laboratory for Neuro-
plasticity, Massachusetts Eye and Ear
Infirmary, Boston, MA.

For individuals who are blind, navigation is a major challenge. “As sighted individuals we take for granted that we can see landmarks that are around us,” says Dr. Lotfi Merabet, who does triple duty as a neuroscientist, optometrist and clinical researcher at Harvard-



Lotfi Merabet, OD, PhD

affiliated Massachusetts Eye and Ear Infirmary in Boston. That includes, he continues, “the natural spatial relationship between objects in our environment as well as our relationship to those objects.” Individuals with visual impairments, he explains, “must use other sensory modalities to create those relationships in their mind. Hearing is a very powerful way to create those relationships.” Touch can also provide relevant information, he adds, “but touch is limited to the objects in one’s grasp.”

Proprioception – a process involving the sensory receptors found chiefly in muscles, tendons, joints and the inner ear, that detect the motion or position of the body – supports navigation, “but that’s an online updating system that doesn’t allow for planning for objects positioned in front of a person

or obstacles yet to be encountered.” Audio, then, generates a very strong sensory input and it was thus to audio-based technologies that Dr. Merabet and his colleagues turned as they worked to understand and enhance navigation tools for those with blindness and visual impairments.

“Some of the most effective technology tools for the blind were developed by individuals who were not designing for the blind,” declares Dr. Merabet. “With a small tweak or a light modification, some non-specialized/consumer tech/instructional tools can be used very effectively by individuals who are severely visually impaired”...e.g. the success of the iPhone.

Neuroscience and Technology: An Interesting Link to London Cabbies

“The concept of navigation, of finding one’s way, has been a neuroscience question for a long time,” Dr. Merabet notes. As an illustrative anecdote, he cites The London Taxi Driver Study (<http://www.ncbi.nlm.nih.gov/pubmed/17024677>) conducted by British investigator Eleanor Maguire (<https://iris.ucl.ac.uk/research/personal/index?upi=EMAGU26>).

Unlike taxi drivers elsewhere in the world, London cabbies go through intense formal training – two years of learning how to navigate through London, a city whose spatial layout is complex. An aspect of this training, Dr. Merabet explains, is mental imagery. “A cabbie-in-training is told, ‘You’re to pick up a fare at Buckingham Palace. Close your eyes and explain how you will deliver that client to his/her destination at Trafalgar Square.’ The cabbie will then explain in detail how he will navigate his cab to the designated destination.”

For Maguire’s study London cabbies in training participated in a brain scan study as they drove through London, enabling the researchers to iden-

tify the parts of their brains utilized in navigation. What researchers found, Dr. Merabet reports, “is that the hippocampus – the part of the brain responsible for memory and way-finding -- was larger in the cabbies than in age-match controlled Londoners who traveled by bus daily.” The reason: bus passengers are more passive as travelers, less attentive to the intricacies of street navigation. “The longer a cabbie drives his taxi in London the larger the hippocampus becomes. That was the first piece of research that demonstrated that the brain is adapting for this purpose.”

After Dr. Merabet and Dr. Sanchez reviewed the London cabbie study they asked, ‘What about blind people? What parts of the brain do they use in navigating their environments?’ Their response to those questions was the genesis of their AbES – audio-based environment simulator – research.

The Flight Simulator Concept as an Audio Navigation Tool

As they pursued their AbES research, Dr. Merabet and his colleagues created an audio-based virtual environment to train navigation skills based on the flight simulator concept used in pilot training. Dr. Merabet explains the connection: “If there’s a new plane rolling out, if pilots will be landing at a new airport or using a different flight strategy, or if the goal is to learn how a pilot will react in various storm conditions, a controlled simulated environment is best – and safest.” In such an environment, Dr. Merabet says, “pilots can run through their paces and learn from their mistakes in a safe and controlled setting.”

Do the decision-making processes and skills

learned in a simulated environment transfer to the real world? Yes, he responds, citing as an example a January 2009 aviation incident known as “The Miracle on the Hudson” in which US Airways Captain Sully Sullenberger, a former fighter pilot, successfully performed an emergency landing of his passenger jetliner in New York’s icy Hudson River. Captain Sullenberger, Dr. Merabet suggests, may have learned how to effectively respond to that emergency scenario in a flight simulator. “When the situation called for him to make such a landing, his mind was primed; he probably knew the procedures he needed to follow in order to perform his task effectively and appropriately rather than having to improvise in the moment and trust his first instincts.”

The situational knowledge and awareness as well as the contextual learning available in a controlled environment, Dr. Merabet points out, “are proven ways to prepare one’s mind not only to solve the problem at hand but to solve that problem in context. I can teach the procedures in a classroom but it’s very different if we go through those procedures in an environment that’s immersive, that’s very similar to the real-world environment. The more similar, the more immersive the environment, the more individuals are able to suspend their disbelief. When they suspend their disbelief and experience contextual learning, the more likely it is that they will consolidate that information and transfer it when called upon in a real-world setting.”

Creating a “Soundscape”

Dr. Merabet’s “soundscape” virtual audio environment enables blind individuals to build navigation skills in order to prepare themselves for



navigation in the physical world. Traversing this simulated audio terrain – usually the interior of an existing building -- requires a mental spatial map. Mental spatial maps can offer users several views, Dr. Merabet explains. “For example, a bird’s eye view provides an overhead perspective, while others may envision themselves walking at ground level.” There is no one-perspective-fits-all mental map, he cautions, because mental maps differ according to individual perspective.

Mental spatial maps are seeded by text-to-speech (TTS) technology in the form of spatialized sound and earcons – a play on “icon” -- which emit an iconic sound indicating the presence of a nearby object, i.e. a knocking sound represents the presence of a door. Explains Dr Merabet, “If the door is on my right I hear that knocking sound in my right ear. If I turn and face the door I hear the knocking sound in both ears. If I now turn again to the right and the door is on my left I hear the knocking sound in my left ear.” The software keeps track of an individual’s orientation in the building “so that as he or she moves through the environment and these sounds and encounters are happening, they are occurring in a manner that allows individuals to identify objects in their environment and to localize those objects in space because they are utilizing their left and right ears to orient and spatially identify the location of the objects.”

Sounds produced by earcons, Dr. Merabet notes, represent objects that are somewhat naturalistic and are easy to comprehend and to remember. “Then we spatialize those sounds so that individuals can become oriented and retain a mental map to aid in the location of those sounds.” The mapping process, he continues, “is internally consistent, because as the virtual environment is navigated every sound is in perfect register. Individuals traversing this environment use a headset or speakers in or-

der to produce a stereo mode of listening that takes advantage of the left and right channels to indicate object location.”

Hearing earcons when using a keyboard, Dr. Merabet insists, “is a simple process. The space bar indicates ‘take a step forward.’ The letters H and K, respectively, indicate ‘turn left’ and ‘turn right’. J is an action button. So, for example, if participants are positioned in front of a door and need to open it they press the J key. The F key is a ‘Where am I?’ key. Disoriented participants may press the F key at any time to obtain positional information.”

According to Dr. Merabet, the spatial mapping TTS technology is coded from scratch using the XNA platform. Developed by Microsoft and commercially available, XNA is a coding language employed by video game developers that is capable of reading a Wave file or an MP3 file. “If I enter a classroom, for example, the MP3 file is played; it’s a basic TTS system that’s combined with spatialized sounds.” For instance, in ascending a stairwell the sound pitch of each step becomes higher. In descent the pitch becomes sequentially lower.

The soundscape’s software enables visually impaired individuals to interact with their audio virtual environment in the same way that pilots interact with a flight simulator. Explains Dr. Merabet, “If I was an instructor in a flight simulator I’d sit next to a pilot and tell him what I wanted him to do, to bank left, bank right or lower the landing gear, for example. That instruction is called directed navigation – and we duplicate it with our software. In other words, a blind individual can sit with a facilitator and via step-by-step directed navigational learning eventually come to understand the layout of a building.

“The blind individual hears, ‘I want you to take two steps forward, take two steps to your right and turn

left. You're now facing the bathroom. If you turn right, on the other side of the corridor is another office." In short, he continues, "the soundscape virtual environment method encourages the same didactic learning that a pilot experiences in a flight simulator, providing additional information to build on baseline knowledge, albeit regarding the layout of a building instead of flying a commercial airliner."

Enter Gamers: 'They Blast Through It!'

"There is a category of blind soundscape participants to whom O&M instructors and researchers teach nothing: gamers," Dr. Merabet declares. "We



tell gamers, 'This is a game. Here are the rules. You are in a building. Jewels are hidden in this building. Your mission is to explore the building and locate the jewels, one by one. When you find each jewel you must bring it outside of the building before you search for the next one. You must be aware that the building contains roving monsters. If the monsters catch you with a jewel they take it from you and hide it at another location in the building. You must then re-explore the building to search for and extricate that jewel cache.'

In his current soundscape study at the Carroll Center for the Blind near Boston, which has tested over 30 participants during the past two years and is funded by the National Institutes of Health, Dr. Merabet says, "We've found that individuals who play this game are more proficient at learning spatial mapping on their own, without significant outside help. They implicitly build a cognitive spatial map in their minds through game-playing." Returning to the analogy of a flight simulator, he adds, "If I place a gamer in a World War II fighter ace game but don't directly teach him/her anything, except to

say, 'These are the plane's controls' and then place the gamer in a WWII fighter ace game scenario he/she will learn how to fly that plane, through trial and error, through contextual learning, through situational knowledge, through awareness, through the rapid response time requirements. Our research demonstrates that utilizing a gaming scenario enables participants to consolidate information faster. We see exactly the same result when there's a navigational purpose."

In his soundscape simulations and spatial map creation experiments, study participants range from ages 14 to 45 and are early- and late-blind for the purpose of strategy comparison. "We asked, 'Does having previous sight versus none at all change the way that the mental map in their minds is formed?'" The researchers, he notes, learned quickly that "our younger population is very excited about the gaming concept and learning through gaming, compared to our older population. So we try to identify those individuals who appear to be more amenable to learning through the gaming strategy."

When Dr. Merabet initiated the use of simulated audio environments he presumed those studies would require weeks to complete because it was assumed that the participants' keyboarding skills would be weak, an assumption that proved to be wrong. "More participants than we anticipated were not only adept keyboarders, they were also adept email and iPhone users who were accustomed to the iconic sounds on their iPhones. This is a natural language – and a natural interface -- for them. They blast through it!"

AudioDoom Was the Prototype

AudioDoom, an immersive audio game based on the popular video game, *Doom*, introduced Dr. Merabet to Dr. Sanchez's early studies of virtual audio navigation skill-building environments for the blind.

“I was attending a U.S. Department of Veterans’ Affairs conference on virtual reality several years ago where a presenter explained the audio-based virtual environment concept. Virtual environments were a hot topic in the U.S. military then. The presenter – Dr. Jaime Sanchez, a professor of computer science at the University of Chile – pointed out that virtual environments did not necessarily have to be visual but could be adapted to other modalities. Dr. Sanchez wanted a way to engage blind children and help them become comfortable with keyboard use so that they could have a way to engage with their friends.

Dr. Sanchez’s students had heard about a popular video game called Doom from TV and they wanted to play too. Professor Sanchez and his group developed an audio version of Doom and dubbed it AudioDoom. “I was very impressed with their work,” recalls Dr. Merabet. “What intrigued me was that the students played the game on their own time. After they completed a level they were given Lego pieces. Each piece represented a door, the location of a monster or a dead end, for example. The children were able to build a one-to-one representation of the level they walked through. This was a hard demonstration that the mental map they were building was exact because their model, when compared it to the physical model, was a perfect representation.”

“I asked, ‘If they play and enjoy the gaming experience and their map is accurate, why not play the game in a location that actually exists?’ That’s when AudioDoom was transformed into an audio-based environment simulator (AbES) by assimilating its earcons and spatialized sound and basing the game on an open existing physical environment.” The transformation resulted in a mechanism that was more than a game; it became a rehabilitative and research tool. “AudioDoom was a game creat-

ed for amusement, but AbES depicted a real-world environment, which represented a step forward in terms of its simulation value.”

AudioMetro, a navigation game based on the physical layout of the Santiago subway, was used to help individuals utilize the city’s underground metro system. Players state their destination and the subway stop where they wish to detrain, Dr. Merabet explains. “Then the software goes through an auditory simulation of what it’s like riding the subway; stops are announced and directions provided, taking players through the sequence that a metro passenger would normally experience. When players arrive at their designated metro station “they possess a mental plan that anticipates the sequence of stations to be encountered, knowing whether a transfer is necessary, where the journey ends and when detraining is called for.” As with his current AbES, Dr. Merabet explains, the objective is for gamers to attempt to transfer the skills learned in simulation into a real-world scenario.

Gamer Meets World: ‘Drop-Off’ Experiments

In O&M, Dr. Merabet says, “we refer to survey knowledge and route knowledge. We think that directed navigation provides route knowledge, which enables an individual to move from point A to point B and C to D. But if I ask an individual to move from point B to point C that individual lacks information – survey knowledge -- about how locations are connected. The advantage of learning through games is that gaming may facilitate the learning of survey knowledge, because players understand the fundamental links between all the rooms and all the paths in a building.”

Once gamers learn the spatial layout of the building represented in the AbES game they are physically delivered to the building and asked to find their way from room to room. Explains Dr. Mera-

bet, “They are brought to a series of pre-determined start points and instructed to exit the building using the shortest path they can locate. From each start point, there are at least three possible paths than can be used to exit the building. We score the path chosen based on a predetermined score method – the shortest possible path is worth three points, the second shortest is two points, the longest path is assigned one point and an unsuccessful exit is awarded no points.

“As the participants were never trained on these paths, we hypothesize that the paths they choose will be a reflection of the way they were trained. Indeed, gamers tend to use the shortest path --as indicated by a higher average path score-- while directed navigators tend to use longer paths corresponding to a route they may have already explicitly learned and as such show a lower path score. The interpretation is that gamers have survey knowledge and can interpolate the appropriate paths regardless of their point of departure. Directed navigators are limited to paths in which they were explicitly trained on reflecting route knowledge.”

Data Collection

Dr. Merabet calls AbES a tractable testing platform to collect quantifiable metrics and monitor learning. “The software we use is designed to measure performance. For example, if I asked the individual to walk through a path virtually from one room to another, the path is recreated via an Excel file, which enables me to learn whether or not the individual succeeded. I’ll know how much time was required for that transit and what path the individual took. I



can break down the path if the individual becomes disoriented and lost.”

This method, he explains, “is a robust way to collect data about an individual and then use that data to track the individual’s progress in monitoring. I can look at pre- and post-AbES data after training. I can also look at a specific population. For instance, I can notice that in general men do better than women or vice versa. I can focus on early-blind versus late-blind. This mechanism allows for data capture that facilitates additional questions. Are the participants improving? Is one learning modality better than another? Is one floor more complicated than another? Do the participants struggle, and how much? This is an evidence-based approach that was not available to us with AudioDoom, which is why we decided to start from scratch and construct our own virtual audio gaming environment that included the features we needed.”

The Future: Mapping Out an Entire Campus

Dr. Merabet’s future projects will aim to counter the misconception among sighted people that individuals who are blind are devoid of a navigational sense. This misconception continues to exist, he says “because our mental maps are thought to be generated through sight and that if individuals lack sight then they cannot generate an accurate mental map.” In fact, he emphasizes, the challenges faced by blind people are less related to the absence of sight and more related to issues of accessibility. Technology may be very helpful in this regard. Therefore, high on Dr. Merabet’s priority list is a project that will entail expanding AbES so that it is capable of mapping the entire campus of Newton’s Carroll Center for the Blind.

“We can imagine a scenario in which we map out the campus and create a gaming metaphor in which players are required to enter one building to locate

the key that gains entrance to the door of another building in which there is a map that allows players to enter a third building in which access codes for a fourth building are provided.

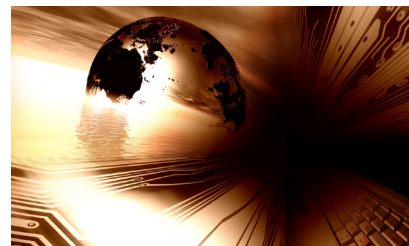
“We can create this large-scale gaming metaphor to force gamers to interact with the whole campus. We can imagine putting that game on a CD, sending the CD to gamers at home who play the game on their own time. When they arrive at the Carroll Center where we do our work they already know the layout of the campus – without ever having set foot there. This makes use of AbES as a rehabilitative tool.”

Dr. Merabet also intends to use the AbES gaming feature as a way to improve the navigational skills of blind individuals who, for whatever reason, experience orientation difficulties. “This project will attempt to demonstrate that given the right learning context, the right motivation and the right information – not too much, not too little – individuals without sight possess the same navigational capabilities as people who are sighted. “

His future research will involve investigating other modalities as well, starting with touch. “We’re experimenting with the Nintendo Wii system. The auditory modality is very proficient in helping individuals become oriented to objects that are far away, not close up. Currently individuals have to encounter an object or a building feature in order to know that it is present. They must literally bump into a wall to know that a wall is there.” The tactile modality, however, “is effective in informing individuals about objects and features in one’s immediate vicinity. If I’m blind I can hit a wall with my cane before I physically touch the wall but I sense nothing beyond the cane’s reach. Our goal is to somehow marry the two to make for an even more effective immersive environment.”

Beyond Navigation and Wayfinding: Fantastic Voyage

Other projects on the horizon, he says, go beyond navigation and wayfinding. “There are projects that teach these



strategies to benefit blind students studying anatomy and science. For instance, instead of navigating through a building we aim to navigate through the human body, similar to the journey depicted in the 1960s movie, *Fantastic Voyage*. Dr. Sanchez has created a prototype in conjunction with the Department of Education in Chile in which blind students are learning biology and anatomy by navigating on a room-by-room basis -- the ‘rooms’ being the four chambers of the heart – and travel through the circulatory system to enter the lungs, then through the mouth and into the digestive system. It’s the same virtual navigation strategy we’ve been using, but for different terrain, utilizing contextual information to learn the parts and functions of the anatomy and how they interact.”

This project, he says, “is really about capturing spatial constructs and the spatial relationships between objects minus the benefit of sight. Navigational wayfinding is a natural solution to this, but I think we can go beyond that from an educational perspective as well. Take geometry, for instance. An anecdotal misconception exists which assumes that geometry cannot be taught to blind students because it’s too visual a concept. I don’t think that’s true. I think with the right context, the right accessibility tools, those same relationships can be taught for blind students as well. The question is, How can we take advantage of the tools we have in order to achieve that result?”

Dovetailing Existing Technology

As far as technology is concerned, he says, “from a software development and accessibility standpoint we are going to operate



on the premise that remaining connected in a digital world requires interaction through a keyboard. We believe that this will continue to be a fact of life. The question then becomes, ‘Can software development enable us to dovetail existing technology for one’s purposes rather than inventing the technology de novo?’ When I presented this premise to my hospital’s ethics committee I was asked, ‘What happens should your study fail and you fail to prove your hypothesis?’ I replied, ‘At the end of the day, these visually impaired kids will be more comfortable using a computer. They’ll be able to interact socially with their friends. The kids can’t lose.’”

His current and future research, he concludes, remains dedicated to addressing the overarching question, ‘What exactly is the visual brain doing to benefit those who cannot see?’ “We don’t have the answer yet,” says Dr. Merabet. “Is it used when blind people are lost, when they find their way, when trying to decide? We haven’t yet been able to disentangle this, but we do know that the visual brain is crucial in allowing a blind person to navigate even though he/she has never seen the physical environment they traverse.”

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RESOURCES

ARTICLES

Audio-Based Navigation Using Virtual Environments: Combining Technology and Neuroscience

By Lotfi B. Merabet, PhD and Jaime Sanchez, PhD
Allen Press (2009)

The authors focus on the combination of technology and neuroscience research to investigate brain function related to sensory processing in the absence of vision. The two researchers discuss audio-based methods of virtual navigation implemented via computer gaming. According to the authors/researchers, the immersive, engaging and heavily interactive nature of the software allows for mental spatial mapping by the severely visually impaired that is transferrable to real-world navigation scenarios.

<http://www.cnib.ca/en/research/news/gaming/Documents/aerj-02-03-128-137.pdf>

Free Computer Games for Blind/Visually Impaired Children

By Donald Westlake
eHow (2012)

The writer urges computer game use by children with visual impairments. He spotlights several websites offering free computer games, 7-128 Software (<http://www.7128.com>) and AudioGames.net (<http://audiogames.net/>).

http://www.ehow.com/way_6259898_computer-games-blind_visually-impaired-children.html

How a Blind Gamer Plays Zelda by Ear

By Jason Schreier
Wired (April 11, 2011)

Terry Garrett lost his sight in 1997 at age 10 but was immediately entranced by a video game, Oddworld: Abe’s Oddysee (<http://www.oddworld.com/2010/08/abes-oddessey/>), which he played by

sound, listening for voices, footsteps and music to compensate for his absence of vision. At first he could not discern the meaning of the various noises, but he persisted until he mastered the game in his own improvised audio format. Today he “reads” the game’s sound design well enough to consistently beat it. To make games more accessible to vision-impaired gamers, Terry recommends that sound designers include as many sounds as possible.

<http://www.wired.com/gamelif/2011/04/blind-gamer-plays-zelda-by-ear/>

How a Blind Teen Sees with Sound

By Daniel Schorn
CBS News (2009)

This CBS News report by correspondent John Blackstone spotlights 14-year-old Ben Underwood who not only excels at using sound as a video gamer but also competes in football by reading sounds.

http://www.cbsnews.com/2100-500202_162-1817689.html

Playing by Ear

Scribd (2011)

This article describes the methods employed by the Carroll Center for the Blind to build navigation skills via audio games. Gamers use headphones to virtually negotiate three-dimensional labyrinths of sound that represent locations and features of an actual physical space, such as the interior of a building. The objective is to help blind gamers feel physically present in the maze’s space. Later, the gamers apply the lessons they have learned virtually in order to negotiate the real corridors that have been virtually represented.

<http://www.scribd.com/doc/72074052/Playing-By-Ear>

WEBSITES

Top 25 Sites for Gamers Who Are Blind – 2012

This Simple Entertainment website lists the 25 blind-accessible gamer sites which, in turn, con-

nect gamers to 183 websites with links to 394 free commercial downloadable games for Windows. The site lists online games, Macgames and accessible mouse-operated games. It also lists accessible iPad, iPhone and Twitter games. Entries in these lists include extensive game descriptions, not reviews.

<http://www.7128.com/top25/topsitesblind.html>

Tvivip.ORG

This website is rich in links and information related to technology for the blind and visually impaired. A “Bulletins” page lists information on new technology under development or in the testing phase. Screens include those related to screen access, Braille translation, games, freeware and shareware, downloads and literacy oriented programs and websites. Screens link to free technology and price lists of technology that is not free. Games designed to be used by the visually impaired population are available for free download, to play online and for purchase. Reading programs are offered as well as online book sites. Downloads are available for JAWS keyboarding, lessons plans, Powerpoints, screen readers, computer voices, cursors, sounds and voice-overs. <http://www.fctd.info/resources/5318>

National Center for Blind Youth in Science

Sponsored by the National Federation for the Blind, the site is designed for students participating in the sciences as well as for parents and teachers. The site includes information about the Junior Science Academy and the Blind Youth Slam, which exposes students to careers that were once considered inappropriate for the blind. The website also information and links for STEM courses (science, technology, engineering, math) with Braille periodic tables, tactile maps, talking thermometers and graphic calculators. There are lists of resources, programs and careers --including a list of blind scientists -- and a link to a science and engineering listserve for

students and a section for teachers that includes lesson plans, teaching tips and instructional video clips. <http://www.fctd.info/resources/5132>

PCS Games

This website features games accessible to blind and visually impaired individuals. The site provides a list of developers, game titles, game descriptions and links. The site differentiates between free and paid games. The website is formatted for a screen reader or for individuals who are vision impaired, with accessible colors and fonts. <http://www.fctd.info/resources/5184>

GAMES

Blindside: The Audio Adventure Video Game

Still in the testing stage, Blindside, designed for all gamers but with visually impaired gamers in mind, is a video game with no graphics, only audio, set in a 3-D environment. According to the game's designers, "This is a game for everyone. The game will be fully accessible to the visually impaired. However, the primary objective of the game is to create a fun gaming experience for all gamers. When complete, the game will be able to be experienced identically by sighted and visually impaired players alike." <http://www.kickstarter.com/projects/600219258/blindside-the-audio-adventure-video-game>

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Assistive Technology in Action

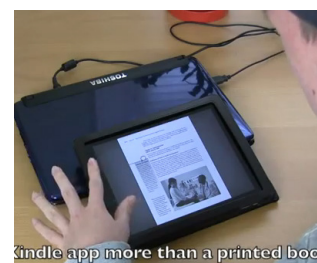
Assistive Technology in Action

An AT Awareness Video Series



The Family Center on Technology and Disability (FCTD) and PACER Center are pleased to announce the release of our new assistive technology awareness series, *AT in Action*. Funded by the U.S. Department of Education's Office of Special Education Programs (OSEP), this fully-captioned video series is designed to strengthen awareness of AT devices that help individuals with disabilities participate fully in school, at home, and in the community. In this first video, you'll meet Sam Graves, a young man with cerebral palsy who, with the help of AT, is a successful college student, blogger, and sportsman. We invite you to view and share this video with your colleagues and the families you serve.

<http://www.youtube.com/watch?v=jYmfrY4Hfk>



KNOWLEDGE NETWORK MEMBERS

Carroll Center for the Blind

The Carroll Center for the Blind provides re-habilitation, skills training, and edu-cational opportuni-ties to individuals with blindness and visual impairments. Carroll Center services focus on independent living skills, computer training, educational and employ-ment services, low vision rehabilitation, communi-ty ori-entation and mobility training, outdoor en-richment programs, and professional development opportunities.

Carroll Center for the Blind

770 Centre Street

Newton, MA 2458

Phone: (617) 969-6200; (800) 852-3131 (toll free)

Fax: (617) 969-6204

Contact Rachel Rosenbaum, President

Email: info@carroll.org

<http://www.fctd.info/organizations/9725>



Perkins School for the Blind

One hundred eighty years old, P e r k i n s , with 200 s t u d e n t s ages birth-22,

is among the oldest schools for the blind in the U.S. In recent years the school opened the Grousbeck Center for Students and Technology. The Center's architecture "presents itself to all the senses, not just the visual. The walls are mostly flat, but now and then one is interrupted by a richly modeled panel. Thus a student can say to another student,



'Meet me at the Bubble Wall,' or the Wave Wall, and the two can connect by touch. Touch works for the feet, too. When paths intersect or change direction, either indoors or out, the texture of the flooring or paving may change too, warning and explaining what's happening." In addition to an inter-active scale model of the entire Perkins campus, the Grousbeck Center showcases a range of assistive technology devices.

For more information, conact:

Perkins School for the Blind

175 North Beacon Street

Watertown, MA 2472

Phone: (617) 924-3434

Contact: Steven M. Rothstein, President

Email: info@perkins.org

<http://www.fctd.info/organizations/11236>

Computer Center for Visually Impaired People (CCVIP)

Housed at Ba-ruch Col-lege of the City Uni-versity of New York (CUNY), CC-



VIP pro-vides assistive technology training to indi-viduals who are visually impaired. The Center pro-vides workshops and seminars on computer basics, assistive technology, access and use of textbooks in DAISY format (Digi-tal Accessible Information Sys-tem) (http://www.daisy.org/about_us) and the use of Kurzweil 1000 text-to-speech software (<http://www.kurzweil-ledu.com/kurzweil-1000-v12-win-dows.html>). Vocational seminars enable partici-pants to explore the Mac computer and Windows. Trainings are supported by individual-ized instruc-tion and coaching.

CCVIP offers a fee for service test that measures website accessibility for blind and visually impaired computer users. The service is offered to businesses and nonprofits and offers feedback on ease of use and specifies what must be done to make an organization's website accessible.

For additional information, contact:

Computer Center for Visually Impaired People
Division of Continuing and Professional Studies;
Baruch College, CUNY

1 Bernard Baruch Way, Box H-648

New York, NY 10010

Phone: (646) 312-1420

Contact: Judith Gerber

Email: judith_gerber@baruch.cuny.edu

<http://www.fctd.info/organizations/10937>

National Association for Parents of Children with Visual Impairments (NAPVI)

NAPVI is a national organization that enables parents to find information and resources for their children who are blind or visually impaired, including those with additional disabilities. The organization maintains an 800 hotline number dedicated to serving families with visually impaired children. Callers can receive information on rare childhood eye diseases; adjusting to blindness; practical hints and adaptations; educational choices and education law. NAPVI connects families with similar concerns; publishes a quarterly newsletter; disseminates a basic information packet; refers callers to appropriate service agencies; networks with other national organizations; and collaborates with scientists on research studies.



For additional information, contact:

National Association for Parents of Children with Visual Impairments (NAPVI)

P.O. Box 317

Watertown, MA 2471

Phone: (617) 972-7441 (800) 562-6265

Fax: (617) 972-7444

Contact Susan LaVenture, Executive Director

Email: napvi@perkins.org

<http://www.fctd.info/organizations/965>

Association for the Education and Rehabilitation of the Blind and Visually Impaired (AER)

Founded in

1984, AER's

4,500 members

are vision professionals in the

following area:

vocational rehabilitation counseling and employment services; multiple disabilities and deafblind; psychosocial services; information and technology; low vision; infant and preschool, orientation and mobility; education curriculum; vision rehabilitation therapy; itinerant personnel, and personnel preparation. Among its activities, AER supports professional and career development, produces publications, and provides scholarships.



For further information, contact:

Association for Education and Rehabilitation of the Blind and Visually Impaired

1703 N. Beauregard Street, Suite 440

Alexandria, VA 22311

Phone: (877) 492-2708 (toll free)

Fax: (703) 671-4500

<http://www.fctd.info/organizations/10936>

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2012 FCTD AT Resources CD-Rom



The Family Center on Technology and Disability's 2012 Assistive Technology CD is a valuable resource for parent workshops and conferences, professional development events, pre-service education classes, and many other venues. From 2-page fact sheets to in-depth guides, our annual CD has something for everyone interested in the use of technology to help children and youth with disabilities participate fully at home, in school and in the community.

To order the CD, please visit
http://www.fctd.info/show/order_form.

Upcoming evaluation of the Family Center on Technology and Disability

This summer, the Center on Disability at the Public Health Institute will contact selected FCTD newsletter recipients by email to get your feedback on FCTD. Later in the summer, they will also invite all newsletter readers to complete an annual evaluation survey. We hope you will participate in these evaluation activities.

Your opinions count!

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